

**What is Claimed Is:**

1. An apparatus useful in a two-stroke cycle engine or a pump, the apparatus comprising:

5 (a) a piston cylinder having a piston cylinder upper portion, a piston cylinder lower portion, a piston cylinder side wall with an interior surface and a piston cylinder top cover, the piston cylinder further having an intake port defined within the piston cylinder upper portion and an exhaust port defined within the piston cylinder lower portion;

10 (b) an intermediate piston cylinder head fixedly disposed within the piston cylinder so as to separate the piston cylinder upper portion from the piston cylinder lower portion, the piston cylinder head extending transversely across the interior of the piston cylinder and having an upper surface and a lower surface, the piston cylinder head being disposed within the piston cylinder so as to define at least one head gap between the interior surface of the piston cylinder side wall and the piston cylinder head;

15 (c) a piston slidably disposed within the piston cylinder, the piston having a piston side wall with an exterior surface, the piston being sized and dimensioned to be operatively sealable with the internal piston cylinder side wall, the piston also having a lower piston portion with a lower piston portion upper surface disposed within the lower piston and an upper piston portion comprising at least one upright extension member, the at least one upright extension member having an uppermost portion, the at least one upright extension member extending upwardly from the lower piston portion through the at least one head gap and being extendable upwardly into the upper cylinder portion, the lower piston portion upper surface being adapted to cooperate with the interior surface of the piston cylinder side wall, the at least one upright extension member and the lower surface of the piston cylinder head to  
20 define an enclosed lower chamber, the piston being operatively connected to a crank shaft by a piston rod and adapted to reciprocate within the piston cylinder between an upward cycle and a downward cycle;

(d) a piston top wall disposed transversely within the piston cylinder and attached to the uppermost portion of the at least one upright extension member, the piston top wall being adapted to cooperate with the interior surface of the piston cylinder side wall to define an enclosed upper chamber in the upper cylinder portion immediately above the piston top wall, the piston top wall also being adapted to cooperate with the at least one upright extension member, the interior surface of the piston cylinder side wall and the upper surface of the piston cylinder head to define an enclosed intermediate chamber immediately below the piston top wall;

(e) a valve for alternatively allowing the transfer of fluids into the intermediate chamber and for alternatively preventing the transfer of fluids from the intermediate chamber; and

(f) means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber and for alternatively preventing the transfer of fluids between the intermediate chamber and the lower chamber.

2. The apparatus of claim 1 further comprising an igniter disposed proximate to the lower chamber for igniting fluids within the lower chamber.

3. The apparatus of claim 1, wherein the intermediate piston cylinder head is disposed within the piston cylinder so as to define a pair of opposed head gaps between the interior surface of the piston cylinder side wall and the piston cylinder head, wherein the at least one upright extension member comprises a pair of opposed upright extension members, and wherein each of the pair of opposed upright extension members extends upwardly from the lower piston portion through one of the two opposed head gaps and is extendable upwardly into the upper piston cylinder portion.

4. The apparatus of claim 1 further comprising an igniter disposed proximate to the lower chamber for igniting fluids within the lower chamber, wherein the intermediate piston cylinder head is disposed within the piston cylinder so as to define a pair of opposed head gaps between the interior surface of the piston cylinder side wall and the piston cylinder head, wherein the at least one upright extension member comprises a pair of opposed upright extension members, and wherein each of the pair of opposed upright extension members extends upwardly from the lower piston portion through one of the two opposed head gaps and is extendable upwardly into the upper piston cylinder portion.

5. The apparatus of claim 1, wherein the valve is an electro-mechanical valve disposed external of the piston cylinder.

6. The apparatus of claim 1, wherein the valve is a flap or reed valve.

7. The apparatus of claim 1, wherein the apparatus is operatively disposed within a two-stroke cycle engine.

8. The apparatus of claim 1, wherein the apparatus is operatively disposed within a pump.

9. An apparatus useful in a two-stroke cycle engine, the apparatus comprising:

(a) a piston cylinder having a piston cylinder upper portion, a piston cylinder lower portion, a piston cylinder side wall with an interior surface and a piston cylinder top cover, the piston cylinder further having an intake port defined within the piston cylinder upper portion and an exhaust port defined within the piston cylinder lower portion;

(b) an intermediate piston cylinder head fixedly disposed within the piston cylinder so as to separate the piston cylinder upper portion from the piston cylinder

lower portion, the piston cylinder head extending transversely across the interior of the piston cylinder and having an upper surface and a lower surface, the piston cylinder head being disposed within the piston cylinder so as to define at least one head gap between the interior surface of the piston cylinder side wall and the piston cylinder head;

5 (c) a piston slidably disposed within the piston cylinder, the piston having a piston side wall with an exterior surface, the piston being sized and dimensioned to be operatively sealable with the interior surface of the piston cylinder side wall, the piston also having a lower piston portion with a lower piston portion upper surface disposed within the lower piston cylinder portion and an upper piston portion comprising at least one upright  
10 extension member, the at least one upright extension member having an uppermost portion, the at least one upright extension member extending upwardly from the lower piston portion through the at least one head gap and being extendable upwardly into the upper cylinder portion, the lower piston portion upper surface being adapted to cooperate with the interior surface of the piston cylinder side wall, the at least one upright extension member and the  
15 lower surface of the piston cylinder head to define an enclosed lower chamber, the piston being operatively connected to a crank shaft by a piston rod and adapted to reciprocate within the piston cylinder between an upward cycle and a downward cycle;

(d) a piston top wall disposed transversely within the piston cylinder and attached to the uppermost portion of the at least one upright extension member, the piston  
20 top wall being adapted to cooperate with the interior surface of the piston cylinder side wall to define an enclosed upper chamber in the upper cylinder portion immediately above the piston top wall, the piston top wall also being adapted to cooperate with the at least one upright extension member, the interior surface of the piston cylinder side wall and the upper surface of the piston cylinder head to define an enclosed intermediate chamber immediately below the  
25 piston top wall;

(e) a valve for alternatively allowing the transfer of fluids between the upper chamber and the intermediate chamber and for alternatively preventing the transfer of fluids between the upper chamber and the intermediate chamber;

(f) means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber and for alternatively preventing the transfer of fluids between the intermediate chamber and the lower chamber; and

(g) an igniter disposed proximate to the lower chamber for igniting fluids within the lower chamber.

10. An apparatus useful in a two-stroke cycle engine, the apparatus comprising:

(a) a piston cylinder having a piston cylinder upper portion, a piston cylinder lower portion, a piston cylinder side wall with an interior surface and a piston cylinder top cover, the piston cylinder further having an intake port defined within the piston cylinder upper portion and an exhaust port defined within the piston cylinder lower portion;

(b) an intermediate piston cylinder head fixedly disposed within the piston cylinder so as to separate the piston cylinder upper portion from the piston cylinder lower portion, the piston cylinder head extending transversely across the interior of the piston cylinder and having an upper surface and a lower surface, the piston cylinder head being disposed within the piston cylinder so as to define a pair of opposed head gaps between the interior surface of the piston cylinder side wall and the piston cylinder head;

(c) a piston slidably disposed within the piston cylinder, the piston having a piston side wall with an exterior surface, the piston being sized and dimensioned to be operatively sealable with the interior surface of the piston cylinder side wall, the piston also having a lower piston portion with a lower piston portion upper surface disposed within the lower piston cylinder portion and an upper piston portion comprising a pair of opposed upright extension members, both having an uppermost portion, each of the pair of opposed upright extension members extending upwardly from the lower piston portion through one of the two opposed head gaps and being extendable upwardly into the upper cylinder portion, the lower piston portion upper surface being adapted to cooperate with the interior surface of the piston cylinder side wall, the upright extension members and the lower surface of the piston cylinder

head to define an enclosed lower chamber, the piston being operatively connected to a crank shaft by a piston rod, and adapted to reciprocate within the piston cylinder between an upward cycle and a downward cycle;

5 (d) a piston top wall disposed transversely within the piston cylinder side wall and attached to each of the uppermost portions of the pair of upright extension members, the piston top wall being disposed to cooperate with the interior surface of the piston cylinder side wall to define an enclosed upper chamber in the upper cylinder portion immediately above the piston top wall, the piston top wall also being adapted to cooperate with the pair of upright extension members, the interior surface of the piston cylinder side wall and  
10 the upper surface of the piston cylinder head to define an enclosed intermediate chamber immediately below the piston top wall;

(e) a valve for alternatively allowing the transfer of fluids between the upper chamber and the intermediate chamber and for alternatively preventing the transfer of fluids between the upper chamber and the intermediate chamber;

15 (f) means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber and for alternatively preventing the transfer of fluids between the intermediate chamber and the lower chamber; and

(g) an igniter disposed proximate to the lower chamber for igniting fluids within the lower chamber.

20 11. The apparatus of claim 10, wherein the valve is an inertial valve disposed within the piston top wall and adapted to open on the downward cycle of the piston and to close on the upward cycle of the piston.

25 12. The apparatus of claim 10, wherein the means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber is a valve.

13. The apparatus of claim 10, wherein the means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber comprises at least one scavenge passage disposed within each of the pair of upright extension members, the scavenge passages being in communication with the intermediate chamber on the upward cycle of the piston and in communication with the intermediate and lower chambers on the downward cycle of the piston.

14. The apparatus of claim 13, wherein each of the pair of upright extension members comprises a plurality of scavenge passages, at least one of the scavenge passages in each of the pair of upright extension members having a top wall and at least one of the scavenge passages in each of the pair of upright extension members not having a top wall.

15. The apparatus of claim 10, further comprising a plurality of spaced apart vertical seal strips mounted in circumferentially-spaced slots in the interior surface of the cylinder wall.

16. The apparatus of claim 15 further comprising springs disposed in the slots to urge the respective vertical seal strips therein radially inward towards the piston.

17. The apparatus of claim 15 wherein the vertical seal strips are slidably disposed within vertical piston slots which are defined in the exterior wall of the piston.

18. The apparatus of claim 10, further comprising a lateral seal strip disposed on each side of the piston cylinder head.

19. The apparatus of claim 10 further comprising a plurality of piston rings disposed in a plurality of spaced apart grooves defined in the exterior surface of the piston, and wherein a plurality of the piston rings have reduced edge portions to enable passage of oil

upwardly along the interior surface of the piston wall.

20. An apparatus useful in a pump, the apparatus comprising:

5 (a) a piston cylinder having a piston cylinder upper portion, a piston cylinder lower portion, a piston cylinder side wall with an internal surface and a piston cylinder top cover, the piston cylinder further having an upper portion intake port defined within the piston cylinder side wall, an intermediate portion intake port defined within the piston cylinder side wall, an upper portion discharge port defined within the piston cylinder side wall and an intermediate portion discharge port defined within the piston cylinder side wall;

10 (b) an intermediate piston cylinder head fixedly disposed within the piston cylinder so as to separate the piston cylinder upper portion from the piston cylinder lower portion, the piston cylinder head extending transversely across the interior of the piston cylinder and having an upper surface and a lower surface, the piston cylinder head being  
15 disposed within the piston cylinder so as to define at least one head gap between the interior surface of the piston cylinder side wall and the piston cylinder head;

(c) a piston slidably disposed within the piston cylinder, the piston having a piston side wall with an exterior surface, the piston being sized and dimensioned to be operatively sealable with the piston cylinder, the piston also having a lower piston portion with  
20 a lower piston portion upper surface disposed within the lower piston cylinder portion and an upper piston portion comprising at least one upright extension member, the at least one upright extension member having an uppermost portion, the at least one upright extension member extending upwardly from the lower piston portion through the at least one head gap and being extendable upwardly into the upper cylinder portion, the lower piston portion upper surface  
25 being adapted to cooperate with the interior surface of the piston cylinder side wall, the at least one upright extension member and the lower surface of the piston cylinder head to define an enclosed lower chamber, the piston being operatively connected to a crank shaft by a piston rod and adapted to reciprocate within the piston cylinder between an upward cycle and a



downward cycle;

(d) a piston top wall disposed transversely to the piston cylinder and attached to the uppermost portion of the at least one upright extension member, the piston top wall being adapted to cooperate with the interior surface of the piston cylinder side wall to define an enclosed upper chamber in the upper cylinder portion immediately above the piston top wall, the piston top wall also being adapted to cooperate with the at least one upright extension member, the interior surface of the piston cylinder side wall and the upper surface of the piston cylinder head to define an enclosed intermediate chamber immediately below the piston top wall;

(e) an upper chamber intake valve for allowing fluids into the upper chamber through the upper portion intake port during the downward cycle of the piston and for preventing fluids from flowing out of the upper chamber through the upper portion intake port during the upward cycle of the piston;

(f) an intermediate chamber intake valve for allowing fluids into the intermediate chamber through the intermediate portion intake port during the upward cycle of the piston and for preventing fluids from flowing out of the intermediate chamber through the intermediate portion intake port during the downward cycle of the piston;

(g) a lower chamber intake valve for allowing fluids into the lower chamber through the intermediate portion intake port during the downward cycle of the piston and for preventing fluids from flowing out of the lower chamber through the intermediate portion intake port during the upward cycle of the piston;

(h) an upper portion discharge valve for allowing fluids to flow out of the upper chamber through the upper portion discharge port during the upward cycle of the piston and for preventing fluids from flowing into the upper chamber through the upper portion discharge port during the downward cycle of the piston;

(i) an intermediate chamber discharge valve for allowing fluids to flow out of the intermediate chamber through the intermediate portion discharge port during the downward cycle of the piston and for preventing fluids from flowing into the intermediate

chamber through the intermediate portion discharge port during the upward cycle of the piston;  
and

(j) a lower chamber discharge valve for allowing fluids to flow out of the lower chamber through the intermediate portion discharge port during the upward cycle of the piston and for preventing fluids from flowing into the lower chamber through the intermediate portion discharge port during the downward cycle of the piston.

21. An apparatus useful in a pump, the apparatus comprising:

(a) a piston cylinder having a piston cylinder upper portion, a piston cylinder lower portion, a piston cylinder side wall with an internal surface and a piston cylinder top cover, the piston cylinder further having an upper portion intake port defined within the piston cylinder side wall, an upper portion discharge port defined within the piston cylinder side wall and an exhaust port defined within the piston cylinder lower portion;

(b) an intermediate piston cylinder head fixedly disposed within the piston cylinder so as to separate the piston cylinder upper portion from the piston cylinder lower portion, the piston cylinder head extending transversely across the interior of the piston cylinder and having an upper surface and a lower surface, the piston cylinder head being disposed within the piston cylinder so as to define at least one head gap between the interior surface of the piston cylinder side wall and the piston cylinder head;

(c) a piston slidably disposed within the piston cylinder, the piston having a piston side wall with an exterior surface, the piston being sized and dimensioned to be operatively sealable with the piston cylinder, the piston also having a lower piston portion with a lower piston portion upper surface disposed within the lower piston cylinder portion and an upper piston portion comprising at least one upright extension member, the at least one upright extension member having an uppermost portion, the at least one upright extension member extending upwardly from the lower piston portion through the at least one head gap and being extendable upwardly into the upper cylinder portion, the lower piston portion upper surface being adapted to cooperate with the interior surface of the piston cylinder side wall, the at least

one upright extension member and the lower surface of the piston cylinder head to define an enclosed lower chamber, the piston being operatively connected to a crank shaft by a piston rod and adapted to reciprocate within the piston cylinder between an upward cycle and a downward cycle;

5 (d) a piston top wall disposed transversely to the piston cylinder and attached to the uppermost portion of the at least one upright extension member, the piston top wall being adapted to cooperate with the interior surface of the piston cylinder side wall to define an enclosed upper chamber in the upper cylinder portion immediately above the piston top wall, the piston top wall also being adapted to cooperate with the at least one upright  
10 extension member, the interior surface of the piston cylinder side wall and the upper surface of the piston cylinder head to define an enclosed intermediate chamber immediately below the piston top wall;

(e) an upper chamber intake valve for allowing fluids into the upper chamber through the upper portion intake port during the downward cycle of the piston and for  
15 preventing fluids from flowing out of the upper chamber through the upper portion intake port during the upward cycle of the piston;

(f) a valve for alternatively allowing the transfer of fluids into the intermediate chamber and for alternatively preventing the transfer of fluids from the intermediate chamber;

20 (g) means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber and for alternatively preventing the transfer of fluids between the intermediate chamber and the lower chamber;

(h) means for alternatively allowing the transfer of fluids between the intermediate chamber and the lower chamber and for alternatively preventing the transfer of  
25 fluids between the intermediate chamber and the lower chamber; and

(i) an igniter disposed proximate to the lower chamber for igniting fluids within the lower chamber.